Oct. 19, 1943. J. B. J. M. ABADIE 2,331,881

LOW VOLTAGE LUMINESCENT TUBE

Filed Jan. 22, 1940

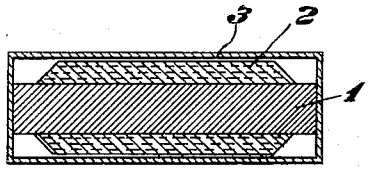


Fig. 1

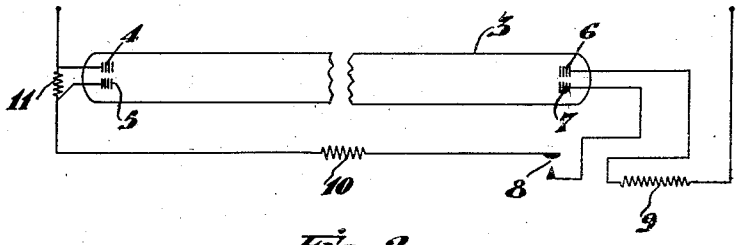


Fig. 2

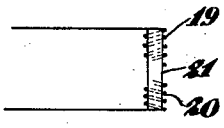


Fig. 3

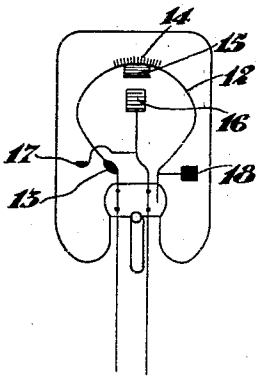


Fig. 4

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LOW VOLTAGE LUMINESCENT TUBE

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1 Claim. (Cl. 176—124)

This invention relates to luminescent tubes and lamps.

The primary objective of the present inventor has been to provide gaseous discharge lamps capable of being operated upon low voltages at high power factor. The term "low voltages" is intended to designate the usual distribution line voltages, for instance, 110—220 volts and the like.

Heretofore the only low voltage luminescent tubes which have been on the market have required very complex auxiliary equipment for their operation, and the power factor of them has been very poor.

A further objective of the inventor has been to provide low voltage tubes organized for instantaneous lighting and relighting when energy is applied to them.

The tubes, briefly, are comprised of the usual transparent envelope containing ionizable gas, and electrodes. They may also contain photo luminescent, fluorescent or phosphorescent materials within or outside the envelope.

However, the lamps of the present invention differ from those which are conventional in the art in several important respects. These, briefly, include the nature of the ionizable filling gas through which the power factor is improved, the electrodes for ionizing the gas, the electrical and electronic interrelationship of the electrodes and the lighting and relighting organization. These features of the tubes of the invention are discussed in the order named in the description which follows.

The drawing illustrates typical embodiments of the various equipment of the tube.

In the drawing, Figure 1 is a diagrammatic view of a choke coil.

Figure 2 is a diagrammatic view of a tube and circuit therefor.

Figure 3 is a detail view of an electrode assembly.

Figure 4 is a diagrammatic view of the assembly for starting the tube and for restarting it instantaneously after it has been illuminated for a period and then deenergized.

Nature of filling gas

A tube having a predetermined diameter and length and operable under a predetermined intensity of current will exhibit a well defined drop in voltage at the poles or the electrodes. But, in order that the power factor equal or approach unity, it is requisite that this tension drop be as high as possible.

Heretofore argon has been used as the ionizable filling gas in conjunction with the vapor of metallic mercury. As the potential gradient of argon is higher than the potential gradient in the tube when the mercury is partially volatilized, the tension or voltage drop at the starting period is higher than it is when the tube has been operating for some short time. This disadvantage may be partially rectified by decreasing the pressure of the argon, but the low pressure of the filling gas reduces the life of the emissive electrodes and consequently the life of the tube itself.

Briefly, the phase of the present invention concerning the filling gas is predicated upon the concept of employing in substitution of the gas, argon, a mixture of gases whose conductability under normal operating conditions is equal to or lower than the conductability of the mixture of mercury vapor and the filling gas.

Gases for the admixture, in accordance with the present invention, are selected argon, neon, helium, crypton and xenon. To illustrate, a typical gaseous admixture in accordance with the invention may be comprised of, say, 80% argon and 20% xenon. With the use of such a gaseous admixture the operating tension of a tube of about 40 millimeter in diameter and having an output of 1 ampere, and operating upon a line voltage of 220 volts, may be evaluated at about 160–180 volts. Other mixtures give similar characteristics.

For low voltage tubes of long length the relative percentage of crypton or xenon in the mixture is increased. For instance, with xenon, tubes of six meters in length have been made to operate on 220 volt current.

The spectrum of xenon, moreover, is very rich in light of ultra short wave length. This characteristic permits of the excitation, to a maximum degree, of fluorescent or luminescent bodies whose maximum of luminosity is attained when they are exposed to radiations of about 2500 Angstrom units. The double silicates of zinc or beryllium and the silicates and tungstenates in general are typical examples of such photo luminescent bodies.

The power factor of a tube is high when the ratio of the normal operating voltage of the tube to the distribution line voltage is of high value. By virtue of the fact that the admixture of gases effects an increase in the normal operating voltage, the power factor of the tube is increased correspondingly. This improvement, in turn leads to the second novel aspect of the invention

namely, a small feeding choke coil of circular formation.

Choke coil

Figure 1 illustrates a typical choke coil of the invention. It is comprised of an internal armature 1, a coil 2 wrapped about the armature and an outer yoke or housing 3 which presents a closed circuit. The housing preferably is made of a single sheet of silicon iron rolled upon itself.

Chokes of such small size are placed at the end or ends of the tube, or beneath each end if an unbroken line of luminescent tubing is desired. In the preferred structure, the choke or chokes are lodged in metal caps placed at the ends of the tubes.

Electrodes

For ionizing the gaseous admixture filling the tube and, particularly for overcoming the relatively high dielectronic cohesion when xenon is used in the admixture, thermo ionic electrodes are employed. In the present tubes these electrodes are brought to emissive state, that is, to the state in which the cathode drop is zero without the use of a transformer, and then an instantaneous tension boost is applied across the electrodes to set the tubes into operation.

In the preferred embodiment the electrodes are provided in pairs for this purpose. The electrodes of one pair are shunted through a resistance. One electrode of the other pair is connected with the choke and an instantaneous circuit breaker controlled by the choke is employed for effecting an instantaneous boost of voltage across the electrodes through the choke.

Figure 2 illustrates a typical tube circuit organized upon this basis. The details of the circuit breaker are shown in Figure 4 and are described at a later point in the specification.

The tube shown in Figure 2 consists of a transparent envelope 3 containing electrodes 4 and 5 placed side by side at the one end and electrodes 6 and 7 placed side by side at the other end.

For the purpose of description of the present circuit it is presumed that the circuit contains only one ballast choke and not a pair of chokes connected in series.

Electrode 4 is connected directly to one of the poles of the operating or distribution line, for instance, a supply line of 220 volts. Electrode 5 is connected with a circuit breaker 8, and the circuit breaker, in turn, is controlled by the choke 9. A small resistance 10 whose purpose is to limit the intensity of the short circuit is placed in series with the electrode 5 and the circuit breaker. The electrodes of one of the pairs 4—5, or 6—7, are shunted by a small resistance coil 11.

When the distribution line voltage is applied to the poles of this circuit the full line voltage is exerted across the electrodes. An arc is formed between the electrodes 6 and 7. Almost immediately thereafter the full tension is applied across the electrodes 4 and 5 as a result of the drop in the voltage across the resistance 11.

The circuit breaker 8 is arranged to open the circuit at this instant. When the circuit is opened instantaneously a tension boost or what might be termed an inductive kick is provided in the choke coil. This boost is in phase with one of the half periods in the current. As the two principal electrodes, for instance, electrode 4 on the one hand and 6 on the other, are in an emissive state the tube lights instantaneously, and this even when hot. Thus, the tube may be relighted as often as desired.

The equipment, therefore, may be said to consist of a small choke 9, two small resistances which may be placed advantageously in the cap of the tube, for instance, in the form of a small resistance wound on a glass tube slipped on the base of the lamp or in a cap of the electrode assembly.

Figure 3 illustrates means for bringing the electrodes to emissive state. The electrode shown in Figure 3 is comprised of a pair of spirals 19 and 20. These are wrapped about a rod 21 which is comprised of an agglomerate containing a heating filament in a refractory mass. For instance, the rod 21 may be made of carbon buried in a vitrified substance, or it may be comprised of a powdery mixture of tungsten, molybdenum, chrome nickel or ferrous nickel, so that the resistance of it is high and so that it will be heated when current is applied across it. A typical rod of this character, approximately 2 centimeters long with a diameter of 3 millimeters, may have a resistance of 500 to 1,000 ohms.

An electrode which is constituted in this manner may be substituted for the electrodes 4—5, or 6—7 of Figure 2, if the tube is to be operated upon alternating current. If the tube is to be operated upon direct current then the electrode of Figure 3 may be substituted for only one of the groups of electrodes, for instance, 6—7 of Figure 2.

When the current is established it passes through the two resistances connected in series, through the circuit breaker to close the circuit, and through the choke. The tension drop in the choke is negligible and the intensity of the current which circulates under such circumstances may be approximately one-tenth ampere—an amount insufficient to cause the circuit breaker to operate.

The rod 21 heats up rapidly and brings the spiral electrodes 19 and 20 to emissive state. These electrodes, for example, may have been treated with an alkaline earth mixture so that they are electrically emissive.

As soon as a temperature of approximately several hundred degrees is obtained arcs are formed between the electrodes 19 and 20 on the rod. The resistance of the rod under these circumstances is cut out of the circuit, and the shunt circuit produced between the electrodes effects the operation of the circuit breaker. The tube then becomes luminescent. The electrode assembly shown in Figure 3 is operable upon current of varying intensity and is suited particularly to the manufacture of tubes in commercial production methods.

Circuit breaker

For breaking the circuit and for providing a boost in the voltage upon the formation of an arc across the electrodes of the assemblies, the circuit breaker must operate almost instantaneously to provide the boost. An air circuit breaker, or one set in oil or gaseous atmosphere, is not suitable since the boost is offset in the arc and the circuit breaker itself. However, the circuit breaker of Figure 4 has been found to have none of these defects.

This breaker is comprised essentially of an evacuated envelope or container. For instance, this container may be of the type shown or may be in the form of a small bulb of the kind used in the manufacture of incandescent lamps. The circuit breaker is installed in the bulb and it is comprised of an elastic band, for instance, a

band of steel or bronze shown at 12. This band is carried by connecting wires which pass through the envelope, the connections to one of the wires being shown at 13, the other end of the blade being carried in the base of the envelope. A small disc of soft steel shown at 14 is installed upon the blade and the blade also carries a contact point 15 which preferably is made of tungsten.

Contact 15 cooperates with contact 16 which is in connection with the other lead wire to the circuit breaker. The elastic band 12 permits the contacts 15 and 16 to come into engagement with one another under the influence of a magnetic field from the choke. Ordinarily these contacts are open.

A pair of "getters" 17 and 18 are installed within the circuit breaker. These getters are employed to absorb any gases which may be given off within the evacuated chamber of the circuit breaker during the operation of the bulb, for instance, any gases which might come about through potential volatilization of the contacts. The getter absorbs the gases and maintains the vacuum. The circuit breaker is installed relative to the choke so that the choke is capable of controlling the operation of the breaker. As soon as current is applied to the tube, contact 15 is separated from the contact 16 by the choke and this provides the instantaneous boost in voltage which is required to set the tube into operation.

By virtue of the use of the band 12, the breaks due to the alternations in the current do not allow contact 15 and contact 16 to come into engagement at each half current period. Moreover, if there is a vacuum in the circuit breaker the tendency of the blade 12 to vibrate, due to the periodicity of the current, is inaudible.

It is to be noted that the use of the circuit breaker in the vacuum allows at each break, instantaneous intensities of the value of several amperes, without deterioration of the contacts, and as a result a current is obtained which reduces the contra-electro-motive force of the tube to a value, say, lower than that of the feed line. The circuit breaker also constitutes a safety appliance. If there is any defect in the luminescent tube, for instance, the entry of air or the establishment of an excessive vacuum, the auxiliary arcs whose establishment is necessary for the operation of the circuit breaker cannot be formed.

In the use of the apparatus of the invention with direct current only one pair of electrodes is necessary at one end of the tube. In other words, the equipment for direct current consists primarily of a small choke to assure the operation of the circuit breaker and of the resistance. The circuit breaker and the choke controlling it can be installed directly adjacent the tube or at some remote point as may be desired.

Having described my invention, I claim:

An apparatus for use in conjunction with a luminescent tube, having a pair of electrodes which are operable in conjunction with a choke coil, said apparatus comprising a circuit breaker for providing a boost of voltage across the electrodes through the choke coil, said circuit breaker including an evacuated envelope, an elastic loop fastened at its ends within said envelope, a contact carried by said elastic loop at a central portion thereof intermediate the ends and movable therewith in response to energization of said choke coil, a stationary contact member positioned to be engaged by said movable contact when the same is actuated by said choke coil, and connector means extending through the wall of said envelope into connection with said contacts respectively.

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